

VIRGINIA DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISION FOR
LOW PERMEABILITY CONCRETES

December 2, 2002c

SECTION 217 of the Specifications is amended as follows:

Section 217.02 (h) is replaced with the following:

- (h) **Fly ash** shall conform to the requirements of Section 241. Class F fly ash shall be between 20 percent and 25 percent by mass of the cementitious material. However, no more than 15 percent of the Portland cement of a standard mixture shall be replaced.

Section 217.02 (k) is amended to add the following:

- (k) **Silica fume** shall conform to the requirements of AASHTO M307 or ASTM C1240. Silica fume shall replace between 7 percent and 10 percent by mass of the cementitious material. Only silica fume at the rate of 3 percent to 7 percent may be added to all combinations to reduce the early permeability after the approval of the Engineer.

Section 217.08 is amended to add the following:

(c) Quality Assurance for Low Permeability Concrete (for Concrete in Bridges Only):

General:

At least two trial batches, using job materials, with permissible combination of cementitious materials shall be prepared, and test specimens shall be cast by the Contractor and tested by the Department for permeability and strength at least a month before the field application. The permeability samples shall be cylindrical specimens with a 4-inch diameter and at least 4-inches in length. They shall be moist-cured as the strength cylinders for acceptance except that the last 3 weeks of cure shall be at 100 degrees Fahrenheit \pm 10 degrees Fahrenheit. Cylinders shall be tested at 28 days in accordance with AASHTO T 277. The test value shall be the result of the average values of tests on two specimens from each batch. Permeability values obtained from trial batches shall be 500 coulombs below the maximum values specified in Table II-17.

Acceptance Tests:

A quality assurance and acceptance procedure that provides for periodic tests of the field concrete for permeability using AASHTO T 277 shall be established. This should include provisions for testing frequency; the range of coulomb values for which full or partial payments would be made; and the values that would require corrective measures to be taken, or rejection of the concrete, should be stated. The following are quality assurance procedures for field evaluations:

A lot shall be a day's production of concrete for the job and shall be used for statistical acceptance procedure for bridge concrete. For each set of cylinders made for compressive strength tests, two additional cylinders shall be made for the permeability test. The Contractor shall be responsible for making all test cylinders, and the Department shall be responsible for the testing of the specimens.

For all classes of concrete, initially one set of permeability cylinders shall be tested for each lot in accordance with AASHTO T 277. If the average coulomb value for this test is

less than the coulomb value shown in Table II-17, the lot will be accepted at the full bid price.

If the average test result exceeds the coulomb value in Table II-17, payment for the concrete in that element shall be reduced 0.005 percent for each coulomb above the coulomb value in Table II-17, however, the reduction in price will not exceed 5 percent of the bid price of the concrete. Concrete with a coulomb value that exceeds the maximum required in Table II-17 by 1000 coulomb will be rejected. However, bridge deck with the coulomb value exceeding the maximum required by over 1000 coulomb may be accepted by the Engineer at 95 percent of the bid price if it has the required strength and meets other specification requirements, and the Contractor applies, at his own expense, an approved epoxy concrete overlay to the top of the deck. In such case deck grooving will not be required. The adjustment to the roadway grade shall be made as required by the Engineer at the Contractor's expense.

Similarly, concrete in abutments and pier caps with coulomb value exceeding the maximum required in Table II-17, by more than 1000 coulomb may be accepted at 95 percent of the bid price if it has the required strength and meets other specification requirements, and the Contractor applies at his own expense, an approved epoxy, Type EP-3B and EP-3T in conformance with the requirements of Section 243.02, on top of the pier cap or abutment seat.

The reduction in the bid prices mentioned above shall be applied to the total volume of concrete in bridge members, eg. deck slab of a single span, deck slab of a group of continuous spans, pier or abutment, for which any portion of the concrete in the member did not meet the permeability test requirements.

SECTION 404 of the Specifications is amended as follows:

Section 404.03(k) 1. Curing Concrete is replaced with the following:

1. **Curing Bridge Deck and Overlay Concrete:** Bridge deck and overlay concrete, including latex modified concrete, shall be moist cured for a minimum of 7 days and until 70 percent of f'c is reached. Moist curing shall be maintained by wet burlap (keep wet) for the duration of the curing and covered with plastic sheeting. Immediately after screeding and until the application of wet burlap and white plastic sheeting (opaque and transparent sheeting may be used when the air temperature falls below 50°F), no surface of the freshly placed concrete shall be allowed to dry. During moist curing, the concrete temperature shall be maintained above 50°F at the outer most surfaces of the concrete mass. Immediately after removing the burlap and plastic sheeting (except for latex-modified concrete), white pigmented curing compound shall be applied while the surface is damp but has no free water standing on it. The application rate shall be 100 to 150 square feet per gallon.

Section 404.03(l) 1. Weather is amended to replace the 4th paragraph with the following:

Protection shall be provided to prevent rapid drying of concrete as a result of low humidity, high wind, higher concrete temperatures than atmospheric temperatures, or combinations thereof. The Contractor shall perform evaporation rate testing for bridge deck placements and concrete overlays. Immediately after screeding and until the application of wet burlap and white polyethylene sheeting, no surface of the freshly mixed concrete shall be allowed to dry. Fogging, with pressure sprayers acceptable to the Engineer and sufficient to maintain a moist surface, shall be required. The protective measures taken shall be sufficient to maintain an evaporation rate at or below 0.10 pounds per square-foot per hour for normal concrete bridge deck placements or 0.05 pounds per square-foot per hour for concrete overlays over the exposed surface of the concrete. Other preventative measures described in ACI 308 can also be used in addition to fogging. Evaporation retardant films may be applied in a fine mist immediately after

screeding to ensure that the surface remains wet until covered. If such materials are used, there shall be no disturbance of the concrete surface after placement of the retardant film and such film shall not be intermixed with the surface mortar. Placement of concrete shall be regulated at a rate such that the finishing operations can be completed and the wet burlap and polyethylene sheeting are placed prior to any drying of the concrete. If plastic shrinkage cracking occurs due to the Contractor's negligence or failure to follow specification requirements, the Engineer may direct the Contractor to make repairs by epoxy injections, concrete removal and replacement or other methods approved by the Engineer at no additional cost to the Department.

Section 404.04 is amended to add after the fifth paragraph the following:

Consolidation: In deck placements, internal vibrators and screeds with vibrating element shall be used. The minimum frequency of the vibrating element shall be 3,000 vibrations per minute. Internal vibration shall be required along transverse and longitudinal edges and joints and areas where the thickness of concrete exceeds 3 inches.

SECTION 405 of the Specifications is amended as follows:

Section 405.05(c) is amended to replace the third paragraph with the following:

Both internal vibrators and external form vibrators shall be used for concrete with strength equal or exceeding 8000 pounds per square inch. The use of external vibration for other concrete will be at the option of the Contractor with approval of the Engineer. Improper placing and vibrating may be cause for rejection.

Section 405.05(f) 4. Is replaced by the following:

The temperature rise in the curing enclosure shall be uniform, with a rate rise of not more than 80 degrees Fahrenheit per hour. Concrete shall be cured at a steam temperature of not more than 180 degrees Fahrenheit, with the steam temperature uniform throughout the curing enclosure, and with a variation of not more than 20 degrees Fahrenheit. Maximum concrete temperature during the curing cycle shall be 190 degrees Fahrenheit. Approved recording thermometers shall be placed so that temperatures can be recorded at a minimum of two locations spaced at or near the third of the length in each curing enclosure and at least one sensor shall measure the temperature in the concrete.

TABLE II-17 Requirements for Hydraulic Cement Concrete of the Specifications is replaced by the following:

**TABLE II-17
Requirements for Hydraulic Cement Concrete**

Class of Concrete	Design Min. Laboratory Compressive Strength at 28 Days (f'c) (psi)	Design Max. Laboratory Permeability at 28 Days (Coulombs)	Nominal Max. Aggregate Size (in)	Min. Cementitious Content (lb./cu yd)	Max. Water /Cementitious Mat. (lb. Water/lb. Cement)	Consistency (in of slump)	Air Content (percent) ¹
A5 Prestressed and other special designs ²	5,000 or as specified on the plans	1,500	1	635	0.40	0-4	4 1/2 ± 1 1/2
A4.5	4,500	2,500	1	635	0.45	2-4	6 1/2 ± 1 1/2
A4 General	4,000	2,500	1	635	0.45	2-4	6 1/2 ± 1 1/2
A4 Post & rails ³	4,000	2,500	0.5	635	0.45	2-5	7 ± 2
A3.5 General	3,500	2,500	1	588	0.49	1-5	6 ± 2
A3 General	3,000	3,500	1	588	0.49	1-5	6 ± 2
A3 Paving	3,000	3,500	1	564	0.49	0-3	6 ± 2
B2 Massive or lightly reinforced	2,200	N.A.	1	494	0.58	0-4	4 ± 2
C1 Massive Unreinforced	1,500	N.A.	1	423	0.71	0-3	4 ± 2
T3 Tremie seal	3,000	N.A.	1	635	0.49	3-6	4 ± 2
Latex hydraulic cement concrete overlay ⁴	3,500	1,500	0.5	658	0.40	4-6	5 ± 2
Silica fume concrete overlay	5,000	1,500	0.5	658 ⁵	0.40	4-7	6 ± 2

¹ When a high-range water reducer is used, the target air content shall be increased 1 percent and the slump shall not exceed 7 inches.

² When Class A5 concrete is used as the finishing bridge deck riding surface, or when it is to be covered with asphalt concrete with or without waterproofing, the air content shall be 5 1/2 ± 1 1/2 percent.

³ When necessary for ease in placement, aggregate No. 7 shall be used in concrete posts, rails, and other thin sections above the top of bridge deck slabs.

⁴ The latex modifier content shall be 3.5 gallons per bag of cement. Slump shall be measured approximately 4.5 minutes after discharge from the mixer.

⁵ Minimum 7 percent silica fume replacement by weight of the total cementitious material.

Note: Contractor may substitute a higher class of concrete for that specified at his expense.

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